

factor into the BAEYER hypothesis, to which altogether too much attention has been paid by chemists and physiologists.

The reviewer feels that the results of the chemist WILLSTÄTTER, who, to paraphrase a statement of JOHANNSEN'S, carries on his physiological studies not as chemistry, but with chemistry, deserve the notice of all physiologists and chemists, and are full of promise of a new attack upon the most fundamental material problem of mankind, namely, the increase of the food supply of the world.—G. K. K. LINK.

The bubble method in photosynthesis.—KNIEP³ has made a critical study of the value of the bubble method for comparing the rate of photosynthesis in water plants under various conditions. From his work it is evident that the method must be applied with great caution. Part I deals with the percentage of oxygen in eliminated gas bubbles. This percentage rises as the rate of bubbling increases, but not in direct proportion. If one were to find the total oxygen production due to photosynthesis, he would need to determine (1) the volume of the eliminated gas with its percentage of oxygen, and (2) the amount of oxygen that diffused into the bathing water. For the analysis of eliminated gas KNIEP used Krogh's apparatus, by which the percentage of oxygen and carbon dioxide can be determined in very small samples of 4–6 mm.³ The amount of oxygen diffusing into the bathing water was determined before and after a period of photosynthesis by WINKLER'S titration method. The percentage of oxygen in the eliminated gas varied from 22.8 per cent in slow photosynthesis to 45 per cent in rapid photosynthesis.

The whole matter is complex. The oxygen production in photosynthesis not only increases the volume of gas in the intercellular spaces and leads to elimination of gas from the cut surface of the stem, but it increases the oxygen percentage in these spaces and thereby steepens or sets up diffusion gradients (falling gradient of oxygen from intercellular spaces to bathing water and of nitrogen in the opposite direction). Carbon dioxide diffusion gradients due to its consumption must be considered also. Hence the amount of gas given off as bubbles and its richness in oxygen and other gases is the resultant of all these processes acting together, a given set of conditions giving one equilibrium and a change in conditions gradually leading to another set of conditions.

Part II presents the influence of water movement upon the bubble outgo. With 1 per cent KHCO_3 in distilled water as the bathing medium, water movement temporarily stops the bubble outgo. With tap water (supersaturated) the outgo of bubbles increases and continues in darkness even in dead plants. This behavior is all explained on the basis of the effect of the water movement upon the gas gradients. On the basis of these results KNIEP pointed out the

³ KNIEP, HANS, Über den Gasaustausch der Wasserpflanzen. Ein Beiträge zur Kutik der Blazenählmethode. *Jahrb. Wiss. Bot.* 56:460–509. 1915. PFEFFER'S Festschrift.

probable errors in the use of the method for studying the rate of photosynthesis as affected by carbon dioxide concentration.

Part III deals with the effect of short periods of darkening of varying length upon the time needed for resumption of bubbling after reillumination. The longer the darkening, within certain limits, the longer the time required for bubble resumption. This is explained by diffusion (during darkening, as determined by the gas gradients) contracting the gas volume in the intracellular spaces and thereby drawing water into these spaces. The longer the period of darkening the greater the contraction. On the basis of these results KNIEP develops in part IV a method for determining the minimum light intensity necessary to produce oxygen elimination into the intracellular spaces, or to give an excess of photosynthetic gas exchange over the respiratory exchange. It is 2.8 candle meters. This paper deals mainly with methods that are to be used later in answering various questions in photosynthesis.—
WILLIAM CROCKER.

Life histories in Laminariaceae.—In his recent investigation of *Saccorhiza bulbosa*, SAUVAGEAU⁴ found that germinating zoospores behave quite at variance with results reported by other workers. Instead of a protonema, as found by WILLIAMS,⁵ DREW,⁶ and KILLIAN,⁷ he found that the erect plant is developed directly, and also⁸ that *Saccorhiza* shows heterogamy and distinct alternation of generations.

After swimming about for a time, the zoospore comes to rest, rounds out, and develops a membrane, becoming an "embryospore." Subsequent behavior determines whether the embryospore is to be a male or female gametophyte. In the latter case the embryospore doubles its diameter, multiplies its chromatophores without division of the nucleus, and in a short time a tube puts out, of about the same diameter as the embryospore, though its length may greatly exceed the diameter; into the tip of this tube the entire contents of the embryospore migrate. Finally the membrane is ruptured and there escapes a single naked uninucleate mass, slightly elongated in form, which remains attached to the mouth of the empty embryospore tube. This naked mass, which is the

⁴ SAUVAGEAU, C., Sur le développement et la biologie d'une Laminaire (*Saccorhiza bulbosa*). Compt. Rend. Acad. Sci. 160:445-448. 1915; 161:740-742. 1915.

⁵ WILLIAMS, J. L., Germination of the zoospore in the Laminariaceae. Rept. British Ass. Adv. Sci. (Bradford) 1900.

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⁶ DREW, G. H., The reproduction and early development of *Laminaria digitata* and *L. saccharina*. Ann. Botany 24:177-190. 1910.

⁷ KILLIAN, K., Beiträge zur Kenntnis der Laminarien. Zeitschr. Bot. 3:433-494. 1911.

⁸ SAUVAGEAU, C., Sur la sexualité hétérogamique d'une Laminaire (*Saccorhiza bulbosa*). Compt. Rend. Acad. Sci. 161:796-799. 1915.